

HOLY SHRINE / TEERTHA KSHETRA PRESERVATION AND DEVELOPMENT - A CONCEPT NOTE

Part 1: Water and Sanitation

1. PREAMBLE:

The heart and soul of *Bharat* find their primordial expression in the sacred shrines and *Teertha Kshetras* spread across its geographical expanse and even beyond. These sites carry the eternal imprint of *Bharatiya* culture, resonating with a spiritual legacy that dates back to time immemorial. While the essence of this cultural and spiritual heritage is sustained through generations by spiritually elevated saints—beings not bound by the limitations of space and time—the physical presence and recognition of these sacred places continue to nurture and preserve the spirit among common practitioners.

Notwithstanding the invasions by foreign forces and the deliberate assaults on symbols of heritage and religious shrines, these sacred spaces have endured through the centuries—sustained by the unwavering patronage of benevolent rulers and saintly individuals who devoted their lives to their preservation. Yet today, they face a new form of intrusion: the unchecked spread of religious tourism. This modern influx is steadily eroding the sanctity of these places and disrupting the fragile ecological balance that surrounds them, posing a grave existential threat to their continued preservation and spiritual relevance.

It is our civilizational responsibility to safeguard these sacred sites from further deterioration and to chart a thoughtful, sustainable path for their future upkeep. Clearly, there is an urgent need for a calibrated, holistic, and eco-centric approach to the restoration and preservation of these places of worship.

2. INTRODUCTION:

This document places a focused emphasis on the vision for Water, Sanitation, and Hygiene (WASH) policy, recognizing it as a foundational pillar in the preservation and revitalization of sacred spaces. However, WASH is not an isolated concern—it is intricately interconnected with broader aspects of human settlement, including agriculture, animal husbandry, forestry, housing, and other related practices. A truly sustainable and effective WASH framework must therefore be approached holistically, addressing both direct and indirect interventions across these interrelated sectors.

In providing recommendations for sustainable solutions, this document aims to outline immediate, short-term, and long-term measures essential not only for restoring the sanctity of these sacred spaces but also for establishing a strategic road map that ensures their preservation, ecological balance, and continued reverence for generations to come.

Life Link Eco Technologies Pvt. Ltd.

Corporate Office

Unit-B-2065, Oberoi Gardens, 2nd Floor, D-Wing,
Chandiwali, Mumbai, 400072, E-mail: lifelink@lifelink.in
Tel. No.: 91-22-25786323/91-22-287477665

Branch Office

Plot No-10-3-761/6,56(3RT), 2nd Floor,
Vijay Nagar Colony, Hyderabad - 500057,
Telangana, Tel. No. 91-40-23348218

Plot No-612, Rasul Garh
Bhubaneswar-751010, Orissa
Tel. no.: 91-674-2580528

Registered Office

Karuna Nivas, Makarbagsahi, Buxibazar,
Cuttack-753001, Orissa, INDIA
Mobile No.: 91-9937195840

3. OBJECTIVES:

- 3.1. To provide the policy guidelines for sustainable water resource management
- 3.2. To provide innovative approach towards Planning of Sanitation system
 - Drainage system towards collection and transportation of wastewater
 - Initiative towards wastewater management.
- 3.3. To provide policy initiative towards solid waste management
- 3.4. To provide guidelines towards infrastructure development (Road, Housing etc.)
- 3.5. To provide guidelines towards prevention of pollution of water resources (consumption, agriculture practice etc.)

In this document (Part 1) we cover only Objectives 3.1 and 3.2 only which is related to water and Sanitation. The other objectives (3.3 - 3.5) shall be covered in a separate document (Part 2)

4. WATER RESOURCE MANAGEMENT

Water is the most vital resource for the sustenance of any human settlement. Freshwater scarcity is no longer confined to arid or semi-arid regions; even areas with abundant rainfall are increasingly facing challenges in accessing safe and reliable water. This growing crisis is largely the result of inefficient rainwater management, characterized by:

- Low water storage capacity,
- Poor groundwater infiltration,
- Significant inter-annual fluctuations in precipitation (especially due to monsoonal patterns), and
- High evaporation rate.

Sacred sites are particularly vulnerable to water scarcity. In addition to meeting the basic needs of their resident populations, they must also support the steady flow of tourists—and even more so during large-scale festive gatherings. Historically, many of these holy places were located along sacred rivers; however, not all such rivers are perennial. Moreover, many sacred sites are located in hilly terrains or ecologically sensitive zones that lack naturally abundant water sources.

Given these varied challenges, a one-size-fits-all approach to water resource management is inadequate. Therefore, any state-led water resource policy must be underpinned by a localized, context-specific strategy, sensitive to the geographic, ecological, and cultural particularities of each site.

4.1 Generic Approach

The availability of water is not uniform at all times. Normally, there will not be enough water in the rivers during dry season when irrigation demand is minimum.

Hence, attempts must be made to harness water which goes as unutilized during the rainy season. The alternatives currently in practice are:

1. to store the surplus water for later use. This is possible only when geologically favorable sites are available. Kariba dam in Zimbabwe stores more than the water stored by all major, medium, and minor reservoir of Bharat.
2. to divert it to a far-off region where it is needed. It is possible through interlinking of rivers. (This approach is widely discussed by the Government for possible implementation from time to time). However, there is risk of river changing its course due to this. As on now there is no unified theory in the world to predict the river morphology.
3. Diverting surplus water through flood flow canals is a common practice in our country. This will help the drought prone areas to meet their either drinking water requirements or irrigation water needs. Adoption of an open channel for conveying large flows is a cost- effective solution. However, closed conduits can also be thought of for small scale utilization to nearby areas from implementation point of view (due to gradient requirements, land acquisition, and initial investment).
4. to decrease the consumption in the irrigation by introducing new agricultural practices. About 86% of groundwater is used only for agricultural activities in Bharat.

Various alternatives for the sustainable development of water resources are:

- Watershed management
- Afforestation
- Groundwater recharge
- Rainwater harvesting
- Wastewater treatment for recycle and reuse.
- Reduce water requirement in agriculture and horticulture by Low cost drip irrigation systems based on gravity flow (We can help identify, design, and plan such activities in the Irrigation and Water supply field for the benefit of small and marginal farmers and other neglected rural segments. This would not only be a step in the right direction but would also improve the productivity of marginal landholdings and thus provide better livelihood to many)

Examples

- Small & Medium Water Supply Schemes
- Drip Kits for Small & Marginal Farmers
- Allied activities to improve income
- Agronomical assistance
- Crop Selection

Life Link can provide specific solutions for the above interventions, which are focussed on eco-friendly approach while designing these systems. Detailed design principles for each of these interventions can be made available in separate document.

4.2 Advanced Tools: Water resource mapping

Water resources fall under the jurisdiction of the State, making state-level water resource mapping an essential prerequisite for informed planning and management. Such mapping is critical to assess the current status of water availability, water balance and supply scenario, flood forecasting and management plans, forecast future demand, understand utilization patterns, and ultimately develop a comprehensive state water budget. These insights serve as a foundation for effective water governance across various regions within the state.

Our Proposal:

With regards to state level water resource planning, Life Link is open to facilitating collaboration between any State Government in India and the Government of Israel, leveraging Israel's advanced expertise in water resource planning and management. Through this partnership, a long-term master plan can be developed to support the strategic, sustainable, and integrated management of the state's water resources.

The outcome of such approach can be onboarded on a single data integration platform with command-and-control center made available with district authorities. The detailed feature of the design and solution platform can be made available in separate documents.

Such a collaboration can significantly enhance the State Government's capacity to plan and execute all aspects of water resource development—from conservation and storage to distribution, reuse, and ecological sustainability.

4.3 Localized water resource planning for Sacred sites: A case study of Ayodhya

Water resource management in sacred geographies requires a nuanced, hyper-local approach. While integrated within broader state-level planning frameworks, localized strategies must account for each site's unique geographical, ecological, and cultural features. These site-specific solutions are vital for ensuring sustainable water availability—especially during peak pilgrimage seasons, when the population can swell dramatically.

4.3.1 Importance of Localized Water Management in Sacred Contexts

Sacred sites like Dhams attract millions of devotees annually. The resulting seasonal surge in water demand places immense stress on local resources. Hyper-local planning, therefore, becomes essential not only to support resident populations but also to accommodate visiting pilgrims sustainably. These plans must combine traditional knowledge systems with modern hydrological science to address challenges such as water scarcity, flood risks, and ecological degradation.

4.3.2 Case Study: The Holy City of Ayodhya

Ayodhya, one of India's holiest cities, is situated along the banks of the perennial **Sarayu River**. Despite its access to a flowing river, Ayodhya's historical water planning showcases an exceptional model of resilience and foresight, particularly in the creation and maintenance of **inland water bodies**.

Traditional Water Systems

Historical accounts and local narratives suggest that Ayodhya once had over **2,200** man-made water bodies, including **kunds (stepwells)** and **ponds**. A recent field survey, however, indicates that only about **900 of these water bodies remain active** today. This still represents a significant hydrological asset for the region.

Functional and Ecological Benefits

These inland water bodies play multiple roles:

- **Soil Erosion Control:** They reduce runoff velocity and sediment displacement, thereby protecting soil integrity and preserving fertility.
- **Water Conservation:** Kunds act as natural reservoirs, storing rainwater for:
 - Irrigation
 - Groundwater recharge
 - Drought management
 - Supplementing municipal supply during shortages
- **Flood Protection:** By absorbing excess rainwater, these bodies mitigate flood risks.
- **Microclimatic Regulation:** Water bodies increase local humidity, which can aid ecological balance and reduce temperature extremes.
- **Ecological Conservation:** They serve as habitats for various flora and fauna and help maintain the region's biodiversity.

4.4 Policy Shift in Domestic Water Supply: Challenges and Proposed Alternatives

In recent years, the Government of India has undertaken a significant policy shift to ensure ***domestic water supply to every household*** by tapping ***rivers and other inland water bodies***. This strategic move is intended to meet the massive and growing demand for potable water while simultaneously addressing the ***alarming decline in groundwater levels***, which has been exacerbated by over-extraction for both domestic and agricultural use.

However, this shift brings with it substantial challenges:

4.4.1 Degrading Quality of Surface Water Sources

Rivers, once considered pristine and reliable sources of drinking water, are now increasingly contaminated. Key sources of river pollution include:

- ***Untreated or partially treated sewage***
- ***Industrial effluent discharge***
- ***Agricultural runoff*** – the ***largest contributor*** to surface water contamination

Despite the drastic deterioration in river water quality over the years, the ***standard water treatment processes remain largely unchanged***, revealing a mismatch between ***source quality*** and ***treatment strategies***.

4.4.2 Limitations of Centralized Water Treatment Practices

A critical review of centralized water treatment in Indian cities highlights several flaws:

1. ***Narrow Contaminant Focus***: The prevailing treatment philosophy often targets only ***suspended solids and microorganisms***, overlooking the presence of ***micro and macro pollutants*** such as:
 - o Heavy metals
 - o Pesticides
 - o Industrial chemicals

- o Organic compounds

2. *Chlorination Risks:*

- o Disinfection is typically carried out at Water Treatment Plants (WTPs) followed by *long-distance transportation*.
 - o During transit, *recontamination* can occur.
 - o Moreover, *chlorine* in the presence of dissolved organic pollutants may form *harmful chloro-organic compounds*, posing *serious health risks*.
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4.4.3 *Conventional Sand Filtration: Inherent Drawbacks*

Standard sand filtration systems suffer from multiple limitations:

- *Capital-intensive* due to large infrastructure requirements
 - *Large land footprint*
 - Only removes *suspended solids up to 100 microns*
 - *Backwashing* is required, consuming *2-3% of treatment capacity*
 - o A recent survey by the author in an Indian state revealed that *backwash water is discharged untreated*, along with sludge, back into the water source
 - o No protocols exist for *backwash water treatment* or *sludge separation*
 - *Ineffective* for treating *dissolved pollutants*
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4.4.4 *Proposed Decentralized Strategy for Safe and Sustainable Water Supply*

System Overview

Figure 1 (referenced but not included here) outlines the *System Dynamics Model* for a *Safe and Sustainable Water Supply and Sanitation Shield*.

Key Features of the Model:

- *Suspended solids removal* near the *source*

- **Disinfection** at the **user-end**, i.e., just before distribution and consumption
 - Rejection of chlorination in favor of **natural disinfection methods**
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4.4.5 Proposed Technologies

1. Removal of Suspended Solids

An efficient alternative to sand filters, widely used in Europe but rarely adopted in Indian public sector systems, is the **Mechanical Disc Filtration System**.

Advantages:

- **Compact footprint:** Requires only **1/10th** the area of conventional sand filters
- Can filter particles down to **20 microns**
- **Minimal backwash water:** Only **1% of feed rate**
- **Zero-discharge system:** Suspended solids captured during backwash are recovered using **bag filters**, ensuring **no release of untreated waste**

2. Removal of Dissolved Pollutants

There is a critical need to raise awareness about **dissolved pollutants**, which may persist even in water that appears “treated” if the **source water** is contaminated.

A viable solution involves deploying **Natural Biological Systems** to treat **primary-treated water** (i.e., water from which suspended solids have already been removed).

Recommended Approach:

- **Advanced Soil Biotechnology (ASBT)** systems offer:
 - **Extremely low life cycle costs**
 - **Effective trace contaminant removal**
- **Pilot projects** for ASBT should be approved and funded to demonstrate viability

- Use of **natural, food-grade disinfectants** instead of chlorine for final disinfection

Further technical details on ASB and natural disinfection will be addressed in a separate document.

4.4.6 Conclusion

India's move towards ensuring water supply to every home must be accompanied by **modern, decentralized, and environmentally responsible technologies**. A one-size-fits-all, centralized approach is no longer sufficient in the face of **changing water quality realities**. With thoughtful integration of **mechanical filtration, biological treatment, and natural disinfection**, the goal of providing **safe and sustainable water for all** can become a practical reality.

4.5. Ecological Restoration of Water Quality in Holy Dhams: A Sustainable Protocol

Holy Dhams across India are often replete with **natural water bodies**—kunds, ponds, and tanks—many of which are attached to temples and revered shrines. These sacred water bodies hold immense **religious, ecological, and cultural** significance. However, the **quality of surface water** in these tanks has been **steadily deteriorating** due to a combination of natural, anthropogenic, and design-related factors.

4.5.1.Key Causes of Water Quality Deterioration

1. Overuse and Misuse:

- o Mass pilgrim activities involving **holy dips**
- o **Laundry** and **line washing** at pond ghats
- o Use of water bodies for **cattle bathing** and **vehicle washing**

2. Poor Water Body Design and Maintenance:

- o Lack of **natural flushing and drainage systems** in traditional kunds

- o **Blockage** of natural inflows/outflows due to rapid and unplanned human settlement

3. **Ingress of Pollutants:**

- o Infiltration of **polluted surface runoff** and wastewater
- o Seepage from **septic tank leach pits** in nearby residential areas

4. **Inappropriate Renovation Practices:**

- o Renovation efforts focusing solely on **beautification**, such as **concretizing embankments**, restrict **aquatic and amphibian ecosystems**
- o Loss of **natural ecological functions**, including **self-purification**, nutrient cycling, and biological disinfection

5. **Ineffective Water Treatment:**

- o Reliance on **chemical treatments** (e.g., **alum** and **lime**) to precipitate suspended solids
- o **Dissolved organic and inorganic pollutants** persist and **accumulate over time**, often reaching **toxic levels**

4.5.2. Need for an Urgent Ecological Approach

There is an **urgent need to transition** from chemically intensive, ad hoc water purification measures to a **holistic ecological model** that enables the **long-term restoration and sustainable maintenance** of sacred water bodies.

4.5.3. Green and Sustainable Solution Approach

A comprehensive, **ecology-based protocol** for restoration and maintenance of holy kunds is proposed below:

1. Baseline Assessment

- **Survey** and **scientific assessment** of the water body
- **Measurement** of surface area, depth, and volume
- **Water quality testing** to determine the nature and level of contamination

- Identification of **contaminant sources** (e.g., sewage, surface runoff, ritual use)

2. Immediate and Long-Term Remedial Measures

- **Immediate interventions** based on contamination severity
- Development of a **long-term ecological maintenance protocol**

3. Physical Impurity Removal

- **Silt Removal:**
 - Use of **specialized non-invasive equipment** to remove settled silt without draining the water body
 - Such equipment has already been **identified and deployed** by government agencies
 - This is generally a **one-time intervention**
- **Suspended Solid Removal:**
 - Deployment of **mechanical filtration systems** for fine particle removal
 - Requires **periodic cleaning and maintenance**
 - Systems are **commercially available** and proven in Indian contexts

4. Chemical Impurity Removal (Natural Methods)

- Implementation of **biological treatment systems**, such as:
 - **Advanced Soil Biotechnology (ASB)**
 - **Biocatalysis** and other nature-based solutions
- These systems support the **natural breakdown** of dissolved pollutants and **restore ecological balance**

5. Disinfection Strategy

- Use of **natural, food-grade disinfectants** for microbial control
- **No chlorination or synthetic chemicals**

- Emphasis on ***biologically safe and sustainable methods*** to achieve potable or ritual-safe water quality

4.5.4. Conclusion

Holy water bodies are not merely functional but ***spiritually and ecologically sacred assets***. Their restoration must not be reduced to beautification alone. Instead, a ***scientifically sound, ecologically sensitive, and culturally appropriate*** strategy is required to ***preserve their sanctity and functionality***.

This protocol advocates a ***complete shift from synthetic chemical reliance to nature-based, sustainable solutions*** that align with both ***traditional wisdom*** and ***modern ecological science***.

The details of the process can be made available in separate document as per requirement.

5. DRAINAGE NETWORK DESIGN FOR RURAL AND SEMI URBAN AREAS

Most ***holy dhams*** in India fall within ***rural or semi-urban habitats***, where ***drainage infrastructure*** plays a critical role in ensuring ***safe and sustainable sanitation***. However, the drainage systems in these areas remain ***largely unorganized***, leading to health hazards, environmental degradation, and inefficiencies in treatment systems.

5.1. Current State of Rural and Peri-Urban Drainage Systems

Drainage networks in such areas typically consist of ***multiple, overlapping systems***:

- ***Open channels with earthen lining***
- ***Open channels with concrete lining***
- ***Box drains constructed from concrete***
- ***Underground sewer lines***

Due to the ***lack of segregation between stormwater and sewage***, these networks often ***carry a mixture of sewage, greywater, and stormwater***. This intermixing poses significant challenges:

- **Combined loads overwhelm sewage treatment plants (STPs)**, especially during the rainy season
- **Treatment efficiency drops** dramatically due to dilution and flow surges
- **Groundwater contamination** from exfiltration, especially in unlined or damaged systems

5.2. Need for Bifurcation and Reengineering

A long-term solution lies in the **bifurcation of stormwater drainage and sewage transport systems**. However, given current infrastructural and financial constraints, **interim solutions** must be explored.

Short-Term Strategy: Eco-Engineering of Open Channels

A **green, eco-engineering approach** to improve the **self-purification capacity** of open drains is a viable, low-cost interim solution, especially for rural and peri-urban dhams.

Key considerations include:

- Acknowledging open channel sewage transport as a **practical reality**
- Recognizing that such systems are often **unhygienic, unaesthetic**, and difficult to manage
- Re-engineering open channels using **eco-designs** to promote **natural treatment** during conveyance

A proprietary in-house design for a “Green Channel” has been developed and may be discussed in a separate document.

5.3. State-of-the-Art Technology: Vacuum Sewage Transport

A **game-changing innovation** in this space is the **vacuum sewage transport system** developed and patented by **Quavac (Netherlands)**, implemented in India through its subsidiary **Quavac India Pvt. Ltd.**

Key Features of the Vacuum Transport System:

- Operates under **negative pressure**, mixing sewage with air
- Ensures **complete isolation from stormwater**

- *Eliminates exfiltration*, thereby *preventing groundwater contamination*
 - *No greenhouse gas emissions* during transport, making it a *green technology*
 - Particularly effective in *dense, narrow, and heritage-sensitive areas* where laying conventional sewer lines is impractical
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5.3.1. Advantages of Vacuum Sewage Systems for Holy Dhams

1. Ideal for Dense Settlements:

- o Well-suited for *small towns* with *narrow roads, dense habitation, and sacred sites* where construction disruption must be minimized.

2. Facilitates Decentralized Treatment:

- o Allows *short-distance underground transport* to *local STPs*, reducing the burden on centralized systems.
- o Already adopted by a few forward-thinking *municipalities*.

3. Asset Reuse:

- o Existing infrastructure for long-distance transport can be *repurposed* for *stormwater management*, particularly in *high-rainfall zones*.

4. Customizable Hybrid Models:

- o Offers flexibility through *hybrid configurations*, combining:
 - *Vacuum transport for sewage*
 - *Engineered open channels* or *existing box drains* for stormwater
 - Design is adaptable to *terrain and density constraints*

5. Septic Tank Integration:

- o Connects *existing septic tanks* to the vacuum network
- o Eliminates the need for *manual sludge collection, transportation, and separate treatment*

- o Offers a ***unified wastewater network*** for ***greywater and blackwater***

6. ***Cost and Environmental Benefits:***

- o Reduces the cost of building separate infrastructure for greywater and sewage
- o Minimizes environmental risks, treatment costs, and ***health hazards***

5.3.2. Conclusion and Way Forward

The sanitation and drainage challenges faced by ***holy dhams*** demand ***context-sensitive, innovative, and ecologically responsible solutions***. While long-term bifurcation of storm and sewage systems remains a goal, the ***integration of vacuum transport technology***, along with ***green reengineering of open channels***, presents a ***pragmatic and scalable*** path forward.

Details of such solution can also be provided as a separate document.

6. WASTEWATER RECYCLE FOR REUSE

6.1. Challenges:

The wastewater treatment capability of India is still far from satisfactory. The following are the challenges that overwhelm the system efficiency.

1. In centralized design, which is being practiced by most urban local bodies, networking each house hold to reach treatment plant is huge capital intensive. Variety of design factors also make it difficult for 100 % networking for all forms of wastewater. In small towns and villages, the organized collection and networking for treatment is almost non-existent. Therefore, major fraction of wastewater goes into nearby sinks untreated.
2. The treatment technologies adopted by the Urban local bodies are electro mechanical equipment intensive; thus, rendering the recurring cost unviable for the government, especially peri urban settlements. The operational sustainability is compromised for the very same reason.
3. The processes generate by products in the form of sludge and greenhouse gases. The quantity of sludge generated is substantial and needs further disposal. Thus, the environmental sustainability factor remains a challenge. The country continues to experiment with several alternatives to choose the best one, which is cost effective and environmentally and operationally sustainable.
Under the circumstances there is urgent need for choice of sustainable technology which can be deployed in small town and villages for cost effective deployment, operational ease, and sustainable performance.

6.2. Sustainable Design Approach:

Traditionally, wastewater treatment in India has emphasized the removal of physical impurities, followed by biological treatment, primarily targeting the reduction of Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) in the aqueous phase. However, this approach has unintentionally generated by-products such as greenhouse gases (GHGs), contributing to air pollution, and bio-sludge, leading to land pollution. The quantity of these by-products often approximates the reduction of dissolved organics in water. Currently, there are no stringent regulations governing these by-products.

As the nation advances toward carbon neutrality and environmental sustainability, aligning with the United Nations' Sustainable Development Goals (SDGs), there is an urgent need to redesign processes to address these objectives. Existing design norms, as recommended by statutory bodies, fail to account for critical issues such as inorganic salts, heavy metals (measured as Total Dissolved Solids - TDS), and micro- pollutants (e.g., chloro-organics, detergents, pharmaceutical residues, and traces of fine chemicals) present in trace amounts.

The progressive degradation of wastewater quality, driven by increased use of pharmaceuticals and fine chemicals in domestic and agricultural applications, has heightened the toxicity of wastewater. These toxic chemicals pose a greater threat to the human food chain than the benign carbon molecules typically measured as BOD. Techniques for measuring these trace chemicals are still evolving. Consequently, there is a pressing need to recalibrate standard discharge norms and realign treatment process designs to incorporate emerging technologies capable of addressing these challenges.

6.3. ASBT Contribution

The advanced Soil Biotechnology (ASBT) process is engineered to address the limitations of conventional Sewage Treatment Plants (STPs) in treating wastewater. Conventional methods have largely overlooked the removal of toxic contaminants, such as detergents and inorganic salts, which are a primary focus of the SBT process.

SBT mimics a terrestrial ecosystem, utilizing natural geological materials (e.g., rock, weathered rock, and soil), natural microbial consortia, and green plants in a packed- bed, three-phase (solid, liquid, and gas) heterogeneous engineered device.

The fundamental reactions driving the SBT process include photosynthesis, microbial respiration, and mineral weathering. Both organic and inorganic pollutants follow natural pathways for removal from the aqueous phase. The heterogeneous solid phase provides multiple reactive sites for physico-chemical and biochemical reactions, including filtration, adsorption, precipitation, oxidation, ion exchange, and redox reactions. These biochemical reactions are facilitated by soil microflora and plant root- zone chemistry.

The diverse ecosystem—comprising plant roots and microorganisms—supports extensive colonization of microflora capable of breaking down complex and toxic organics into simpler forms, which are mineralized in the soil. Plants absorb

inorganic salts, fixing them in biomass, which is periodically harvested to prevent inorganic accumulation.

Unlike the homogeneous aqueous-phase reactions in conventional treatment plants, where reaction time is constrained by reactor residence time, the SBT media matrix provides virtually infinite residence time for complex chemicals to decompose into simple molecules. These molecules are subsequently utilized by soil organisms and plants.

The terrestrial ecosystem under unsaturated flow conditions (as opposed to submerged flow in wetlands) creates an ideal environment for shrubs and creepers, maximizing biomass production and nutrient uptake by plants, thereby reducing Total Dissolved Solids (TDS) in treated water.

In summary, the SBT system transforms pollutants into simpler, non-toxic forms and integrates them into soil processes, yielding biomass such as fiber, fodder, flowers, and fuel. Conversely, conventional systems generate sludge and gaseous by-products that require additional disposal measures.

6.4. Performance track Record:

Advanced Soil Biotechnology (ASBT) systems have been successfully implemented at **over 200 locations across India**, ranging from **single-family units** to large-scale installations serving the equivalent of **10,000 families**.

Many of these systems have been **operational for more than two decades**, providing strong evidence of the **long-term sustainability, reliability, and ecological efficiency** of the technology.

The installations span a wide range of sectors, including:

- **Government bodies**
- **Urban Local Bodies (ULBs)**
- **Private enterprises**
- **Non-governmental organizations (NGOs)**

This diverse user base reflects the **versatility and adaptability** of ASBT solutions across varied operational and environmental conditions.

A **comprehensive technical dossier** detailing system design, performance metrics, maintenance protocols, and case studies is available upon request.

Sustainable solutions for water supply and sanitation

